to attempt the transmission again (go to step 1) until only one computer transmits and the others defer. The condition wherein two (or more) computers' transmissions interfere with others is known as a **collision**.

The reason two computers waiting to transmit may not sense the other's transmission immediately arises because of the finite propagation speed of voltage signals through the coaxial cable. The longest time any computer must wait to determine if its transmissions do not encounter interference is

$$\frac{2L}{c}$$

where *L* is the coaxial cable's length. The maximum-length-specification for Ethernet is 1 km. Assuming a propagation speed of 2/3 the speed of light, this time interval is more than 10 *μs*. As analyzed in Problem 22 (Information Communication Problems (Page 325)), the number of these time intervals required to resolve the collision is, on the average, less than two!

Exercise 6.36.2

Why does the factor of two enter into this equation? (Consider the worst-case situation of two transmitting computers located at the Ethernet's ends.)

Thus, despite not having separate communication paths among the computers to coordinate their transmissions, the Ethernet random access protocol allows computers to communicate without only a slight degradation in efficiency, as measured by the time taken to resolve collisions relative to the time the Ethernet is used to transmit information.

A subtle consideration in Ethernet is the minimum packet size P_{min}. The time required to transmit such packets equals

$$\frac{P_{min}}{C}$$

where *C* is the Ethernet's capacity in bps. Ethernet now comes in two different types, *C* each with individual specifications, the most distinguishing of which is capacity: 10 Mbps and 100 Mbps. If the minimum transmission time is such that the beginning of the packet has not propagated the full length of the Ethernet before the end-of-transmission, it is possible that two computers will begin transmission at the same time and, by the time their transmissions cease, the other's packet will not have propagated to the other. In this case, computers in-between the two will sense a collision, which renders both computer's transmissions senseless to them, without the two transmitting computers knowing a collision has occurred at all! For Ethernet to succeed, we must have the minimum packet transmission time exceed **twice** the voltage propagation time:

$$\frac{P_{min}}{C} > \frac{2L}{c}$$

or

$$P_{min} > \frac{2LC}{c} \tag{6.63}$$

Thus, for the 10 Mbps Ethernet having a 1 km maximum length specifcation, the minimum packet size is 200 bits.